Reference Dept.

TEXTILE RESEARCH

Publication of Textile Research Institute, Inc., and The Textile Foundation

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IN THIS ISSUE

Announcement of Annual Meeting of Textile Research Institute, Inc. 314

Transfer of Research to Princeton 315

The Institute's Study of Radiant Energy Drying .. 317

The Quality Control Chart Technique in Applied Textile Research 319

Selected Ordinate Method for Interpretation of Spectrophotometric Data 326

Control of Continuous Processes 333

Research Activities 318

Research Aids 343

Abstracts 344

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TEXTILE RESEARCH

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In This Month's Issue

Transfer of Research to Princeton

Immediate transfer of the Textile Foundation's program of fundamental research to the Institute's new property at Princeton, N. J., has been decided upon. Also under a fellowship plan, the research training program of the Institute will be put into effect for the academic year 1944–45. (See page 315.)

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Radiant Energy Drying

A study of radiant energy drying is being conducted by Textile Research Institute, Inc., at its applied research laboratories in Princeton, N. J. (See page 315).

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The Quality Control Chart Technique in Applied Textile Research

How the control chart was used to demonstrate the superiority of a new test technique as compared to a test method formerly used is described. The control chart was also used to compare the output quality of a card equipped with an attachment for improving the quality of roving with that of a card not so equipped. (See page 319.)

* * *

Selected Ordinate Method for Interpretation of Spectrophotometric Data

Detailed calculations of a set of ordinates proposed as a standard to be used in interpreting spectrophotometric data in testing camouflage samples are presented. (See page 326.)

* * *

Control of Continuous Processes

Experiments are described which will be of interest to textile men concerned with operations in which a web of material is immersed in a saturating bath, subjected to pressure between rolls, and dried. (See page 333.)

Annual Meeting of the Institute

"The Textile Industry—Re-Birth or Second Childhood?", the subject of an address by Dr. Gustavus J. Esselen at the luncheon of the annual meeting of the Textile Research Institute, Inc., at the Hotel Roosevelt, New York, Nov. 10, 12.30 p.m., will also be the theme of the meeting as a whole.

At the other sessions, the progress of the Institute on several fronts—fundamental research, applied research, economic research, and education—will be reported and discussed.

The first session will start at 10 a.m., and will be conducted by Wm. D. Appel, chairman of the applied research committee of the Institute, and Giles E. Hopkins, director of applied research. Subjects to be covered will include: (1) the cotton carding project, in a report by Prof. Elliot Grover, of the North Carolina State College Textile School; (2) warp sizing by Prof. William Shinn, also of the North Carolina State College Textile School; and (3) the radiation drying project, by Dr. Richard Wilhelm, of the Institute's applied research staff at Princeton, N. J.

The members' business meeting, at 11.30 a.m., will be brief and will include election of officers and directors; action on proposed changes in the by-laws; and report of the president and executive secretary, Fessenden S. Blanchard.

The first session after the luncheon will be held at 2.30, and will be conducted by Robert R. West, chairman of the economic research committee, and Douglas G. Woolf, director of economic research. Dr. A. M. McIsaac, of the department of economics of Princeton University, will present a report on the project of the post-war status of the textile industry, now being conducted under his direction. At this same session, Dr. Fred M. Feiker, chairman of the educational committee of the Textile Foundation and of the Institute, will report on the progress of that committee.

The last session, starting at 3.30 p.m., will be conducted by Dr. Robert E. Rose, chairman of the fundamental research committee of the Institute, and chairman of the scientific advisory committee of the Foundation, and will deal with fundamental research possibilities and opportunities in the post-war textile industry.

All persons interested in the textile industry and in textile research, whether or not members of the Institute, are invited to attend all sessions of the annual meeting except the business session, which is open to members only. Requests for reservations for the luncheon should be sent to the Textile Research Institute, Inc., 10 East 40th Street, New York 16, N. Y. Luncheon tickets are $2.50 each. Attendance at other sessions is free, and there will be no registration fee.

This is a strategic period in the development of textile research. Representatives of all organizations engaged in textile research are particularly invited to attend.

Institute's Graduate Training to Start Now, As Result of Textile Foundation's

Transfer of Research to Princeton

The board of directors of the Textile Foundation has decided upon the immediate transfer of its program of fundamental research in the field of textile science from the National Bureau of Standards, Washington, D. C., where this research program has been carried out for the last eight years, to a new location at Princeton, N. J., in a property provided by the Textile Research Institute, Inc. As a result of this transfer it becomes possible to integrate the research effort of the Textile Foundation with the program of training and education at the graduate level which forms one of the five objectives of the Textile Research Institute in its campaign to provide the entire textile industry, covering natural and synthetic fibers alike, with a research organization and personnel adequate to the needs and problems of the post-war era.

Through the courtesy of President H. W. Dodds of Princeton University, the Textile Foundation has secured the part-time services of Professor Henry Eyring as acting director of the research program of the Textile Foundation and the Textile Research Institute. Under his direction it is planned to engage immediately in a broad program of research effort in the chemistry and physics of fibers and to initiate, under a fellowship plan, the educational activities of the Textile Research Institute. The decision to initiate this immediately instead of in the post-war period permits the research training program to go into effect during the academic year 1944-45, thus advancing by at least a year the provision of trained personnel for the post-war era.

Dr. Robert E. Rose, of Penn's Grove, N. J., who recently retired from his position as director of the E. I. du Pont de Nemours & Co., technical laboratory, and who is chairman of the scientific advisory committees of both the Textile Foundation and the Textile Research Institute, has agreed to associate himself with the development as Research Counselor of both organizations, and will cooperate with Professor Eyring in the solution of the problems involved.

During the war years, the Textile Foundation has placed practically all of its research facilities in Washington at the disposition of Government agencies for the solution of urgent war problems. These activities will be maintained by the Foundation at Washington, D. C., until the expiration of all existing Government contracts. Dr. Milton Harris, who has been director of the Foundation's research activities in the Washington area, has attained a nation-wide recognition in scientific circles. At the conclusion of the war contracts about the

first of the year, Dr. Harris plans to retire from his position to engage with some of his associates in private practice in the textile research field.

Dr. Eyring, as professor of physical chemistry at Princeton University since 1936, has established both a national and international reputation as one of the outstanding physical chemists of today. Born in Mexico of American parents in 1901 he received the B.S. degree from the University of Arizona in 1923 and the Ph.D. degree from the University of California in 1927.

During 1929–30 he studied in the Kaiser Wilhelm Institute for physical chemistry in Berlin in collaboration with Dr. M. Polanyi. Out of this association Dr. Eyring has developed for himself, as a member of the department of chemistry at Princeton since 1931, a position as author and outstanding exponent of the modern theory of reaction rates in chemical processes He is the senior author of texts on "The Theory of Rate Processes" and "Quantum Chemistry," has contributed numerous special chapters to various texts of colloid and high polymer chemistry, and is the author of upwards of 100 papers in his special fields of physico-chemical science.

In accepting the position of acting director, Professor Eyring will initiate the conduct of research and prepare detailed plans for the training of research fellows. He will assist the Foundation and the Institute in securing for those organizations, in the post-war period, a full-time director of research, and full-time research workers.

Dr. Rose received his Ph.D. at Leipzig, 1903; was assistant at St. Andrews College in Scotland, 1903–05; lecturer and demonstrator in chemistry, University College of Nottingham, 1905–07; assistant professor, University of Washington, 1907–17; fellow at Mellon Institute, 1917; organic chemist at Du Pont, 1917–21; director of the technical laboratory at Du Pont, 1931 until his retirement.

Institute's Membership Increases Sharply

Progress in connection with two of the major projects of the Textile Research Institute, Inc., was reported to the board of directors at a recent meeting. At the same time, and reflecting this acceleration in the Institute's program, there was reported a sharp increase in its membership.

In addition to the project involving study of radiant energy drying, covered elsewhere in this issue, progress on the economic research project was reported to the directors by Robert R. West, chairman of the economic research committee, and Douglas G. Woolf, director of economic research. This project involves a study of the probable competitive position of the American textile industry in the post-war era. It is being financed by the Textile Foundation.

The sharp increase in membership was reported by Major D. B. MacMaster, director of the research fund committee. There are now 142 member companies, of whom 80 are former members which have rejoined under the new membership plan, and 62 are companies previously unconnected with the Institute.

Textile Research Institute Announces Study of

Radiant Energy Drying

Details of the study of radiant energy drying being conducted by the Textile Research Institute, Inc., at its applied research laboratories in Princton, N. J., have been announced by Giles E. Hopkins, director of applied research. This program includes an investigation to obtain basic data on the behavior of common textile materials when dried by application of radiant energy.

The early studies will include radiant heat obtained from various types of electric lamps and, for reference, energy from more limited ranges of wave length in both the luminous and non-luminous fields. The comparative heat penetration and drying rates for the common range of fibers in loose form, as yarns, fabrics and as felts, will be included. The results will be of interest to all sections of the industry.

The work will be confined to the determination of basic information that will be of value as a guide in selecting suitable types of radiant drying for special applications. It will not include studies of reflectors, drier design, and problems of applivation. Later work is planned for studies with alternate energy sources such as incandescent tile.

The study is under the immediate direction of Dr. Richard Wilhelm, who is assisted by Dr. George T. Paul, both of the Institute staff. Dr. Wilhelm has recently been engaged in studies on the application of infra-red radiation to the drying of foodstuffs.

Arrangements have been made to correlate the study with current investigations now being carried on by committees of the American Society of Mechanical Engineers, through W. O. Jelleme, director of development of the Pacific Mills and chairman of the A.S.M.E. Sub-Committee on Heat Processing and Curing Equipment. It will also be integrated with the results of previous studies of convection drying of textiles carried on by the Institute under Dr. Wiegerink. Dr. Walker of the Bell Telephone Co., Dr. Fred Bonnet of the American Viscose Co., and W. D. Appel of the Bureau of Standards, who closely followed the previous work, are acting as special advisors with other members of the applied research committee.

Several exploratory studies of additional projects approved by the applied research committee are under way, as well as investigations of additional proposed specially-sponsored work.

RESEARCH ACTIVITIES

Third National Chemical Exposition will be held November 15–19, 1944 at the Chicago Coliseum. Headquarters for the show are located at the American Chemical Society, 330 So. Wells St., Chicago 6, Ill. One of the interesting features of the Exposition, as in previous years, will be the National Industrial Chemical Conference.

The fall evening courses in textiles at Columbia University are now in progress. H. R. Mauersberger is in charge of these courses which include: Spinning and Weaving of Rayon and Spun Rayon goods, conducted by H. R. Mauersberger, Thursdays; Textile Chemistry, conducted by A. K. Gyzander, Fridays; Woolen and Worsted Manufacture, conducted by Werner von Bergen, Mondays; Spinning and Weaving of Cotton, conducted by John Hagen, Tuesdays; and Identification, Analysis, and Testing of Textiles, conducted by G. R. Turner, Wednesdays. These courses will end in January, 1945. Inquiries should be addressed to the Registrar, Columbia University, Extension Division, 116th St. and Broadway, New York, N. Y.

An electronics training course designed to give in a clear, understandable manner the basic principles and applications of electronics in industry has been prepared by Westinghouse Electric and Manufacturing Company. Although designed primarily for Westinghouse employees, the new ten-part training course covered by sound slide films, lesson books, quiz books, and an instructor's manual has been made available to others at reproduction costs because of the many requests from engineering groups and individuals interested in electronics. For further information write to Westinghouse Editorial Service, 306 Fourth Avenue, Pittsburgh 30, Pa.

The Textile Colorist, recently purchased by the Howes Publishing Co., publishers of the *American Dyestuff Reporter* and the *Knit Goods Weekly* will, in the future, be devoted to the styling, color, finish, and merchandising of textiles. The first issue of the new magazine, which will henceforth be entitled *Textile Colorist and Converter* is being issued in October. Miss Ruth Corby, former editor of the Domestics Section of *Daily News Record* has been appointed editor.

A patent for a portable apparatus for testing the relative porosities of various materials has been issued to Stuart H. Hahn and Robert H. Judson and assigned to The B. F. Goodrich Co., Akron, Ohio. Porosity is tested by the degree of vacuum in the chamber, indicating the rate of flow of air or gases through the material. The apparatus consists of a vacuum chamber placed in contact with the material to be tested, a constant speed power driven fan for evacuating air from the vacuum chamber, an outlet port for emitting the air, and a pressure gauge to measure the degree of partial vacuum in the chamber.

The Quality Control Chart Technique in Applied Textile Research

By O. P. BECKWITH*

The application of the control chart technique in the presentation and interpretation of inspection data has increased the effectiveness of quality control in textile manufacturing. In applied textile research the control chart method can make a valuable contribution. It may be likened to a new tool or machine which does the job of presentation and interpretation of research data more effectively and in less time than the old. The profit in the application of this technique lies in increasing the personal efficiency of the research worker. Its usefulness has not been readily appreciated by research men, in the writer's experience, perhaps because they feel that the qualities of creative imagination, ingenuity and technical skill play so large a part in successful research that the benefits to be obtained from these statistical techniques are not worth the time taken in learning how to apply them. Such a rationalization is a reasonable one. It is the purpose of this discussion to show by simple illustrations how some of the techniques now being applied in statistical quality control can be used to good advantage in research.

* Research Engineer, Alex. Smith & Sons Carpet Co., Yonkers, N. Y.

The development of testing and test methods is the basis of much of our applied textile research, for the creation of a means of simulating under controlled conditions what happens to a material in processing or service is fundamental to the advancement of knowledge on that material. When a testing method is developed its reliability is generally gaged by whether or not it gives uniform results on the same material. The simple tabulation or plotting of data and measures of dispersion has been a means of showing this.

How should the characteristic of reproducibility be judged? Experience in the collection and interpretation of data and knowledge of the material he is working with enable the research worker to do a good job of evaluation as is evidenced by the past progress of research. But it can be done even better by the establishment of a criterion which specifies that variation in the data which exists due to chance alone or which specifies whether or not a state of controlled conditions has actually been obtained. If the criterion is not met then it is highly probable that some assignable cause exists which, if the test is reviewed and studied, may generally be found and corrected. The quality control chart technique described in the A.S.T.M. Manual on Presentation of Data and in American War Standards Z1.1, Z1.2

Table I.—Comparison of two test methods

Sample No.	Old Method No. of Tests	Old Method Average $\bar{X}$	Old Method Std. Dev.	New Method No. of Tests	New Method Average $\bar{X}$	New Method Std. Dev.
1	10	18.4	0.86	10	25.9	1.40
2	8	18.5	1.41	8	24.5	0.86
3	10	18.1	0.79	10	25.3	0.91
4	8	15.3	1.55	8	24.4	0.79
5	10	15.9	1.77	10	25.3	1.44
6	10	17.2	1.47	10	26.1	1.23
7	10	16.6	0.87	10	25.9	1.10
8	10	17.0	1.35	10	26.0	1.36
9	10	17.4	1.51	10	25.2	1.38
10	10	16.3	1.60	10	26.2	1.13
Grand Average, $\bar{\bar{X}}$		17.1			25.5	
Universe Std. Deviation			1.44			1.26

and Zl.3 [1] works effectively in determining whether or not reproducibility of results has been obtained.

In effect the employment of such a criterion in evaluating a set of data functions as a rigid self criticism of the research man's creation. Having developed an ingenious apparatus the worker may have a parental blindness to its not obvious shortcomings, but with the employment of statistical criteria in the evaluation of the test data, critical appraisal is made, which, if the criteria are not met, can act to spur the worker to review and improvement.

The following illustration helps to illustrate the critical value of the control chart criterion. Several years ago a test method was developed in the Alexander Smith laboratories. The data on which the adoption of this test was based are not now available. Its intended use was to evaluate the relative abrasive wear resistance of fibers, and while it proved satisfactory in some cases, its efficiency in general or its correlation was low. Recently a technician in another organization had occasion to use the same test method. Either through greater ingenuity or because of a fresh viewpoint or from plain dissatisfaction with the test he made a fairly simple change in technique which gave very interesting results. The two methods were then studied in the Smith laboratories and a comparison was made of the results from each on the same material. These data are given in Table I. Control charts for each set of tests are shown in Figure 1. It will be noted that the old method shows lack of control; one point falls outside the limits, while the new method shows control since no points fall outside the limits. The new method shows less variability than the old as is evidenced by the universe standard deviations and the spread of the control limits. Further, the average level by the new method is almost 50% greater than that of the old, indicating that perhaps an association be-

[1] A.S.T.M. Manual on Presentation of Data. American Society for Testing Materials, Philadelphia, Pa., 1940.

American War Standards Zl.1—1941, Zl.2—1941, Zl.3—1942, American Standards Association, New York, N. Y.

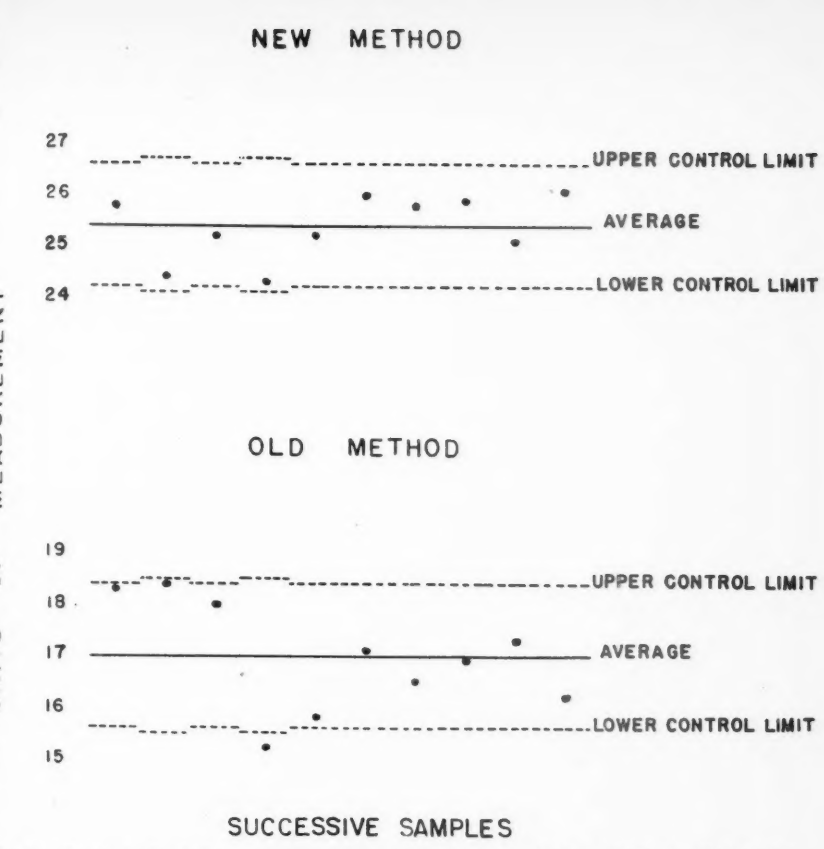

Fig. 1. Control chart for averages. Comparison of two test methods studied in laboratories of Alexander Smith & Sons Carpet Co.

tween the characteristic tested and abrasive wear may exist where previous study, using the old method, showed little or no correlation.

Had the same criterion as that applied in Figure 1 been used at the inception of the old test method it might have caused a search for improvement and a development of the technique of the new test several years before it actually occurred.

The moral of the example cited may be that two heads in research are better than one. But it is not often possible to have one man's work carefully reviewed and studied by another or to have several heads on one job. The critical value of the control chart criteria can help to make up for numbers for it will demonstrate shortcomings of a testing device or method if these do exist. The realization that the test does not meet the criterion imposed is a self applied stimulus towards improvement.

One of the problems constantly facing textile manufacturers is how to decide whether or not to buy new

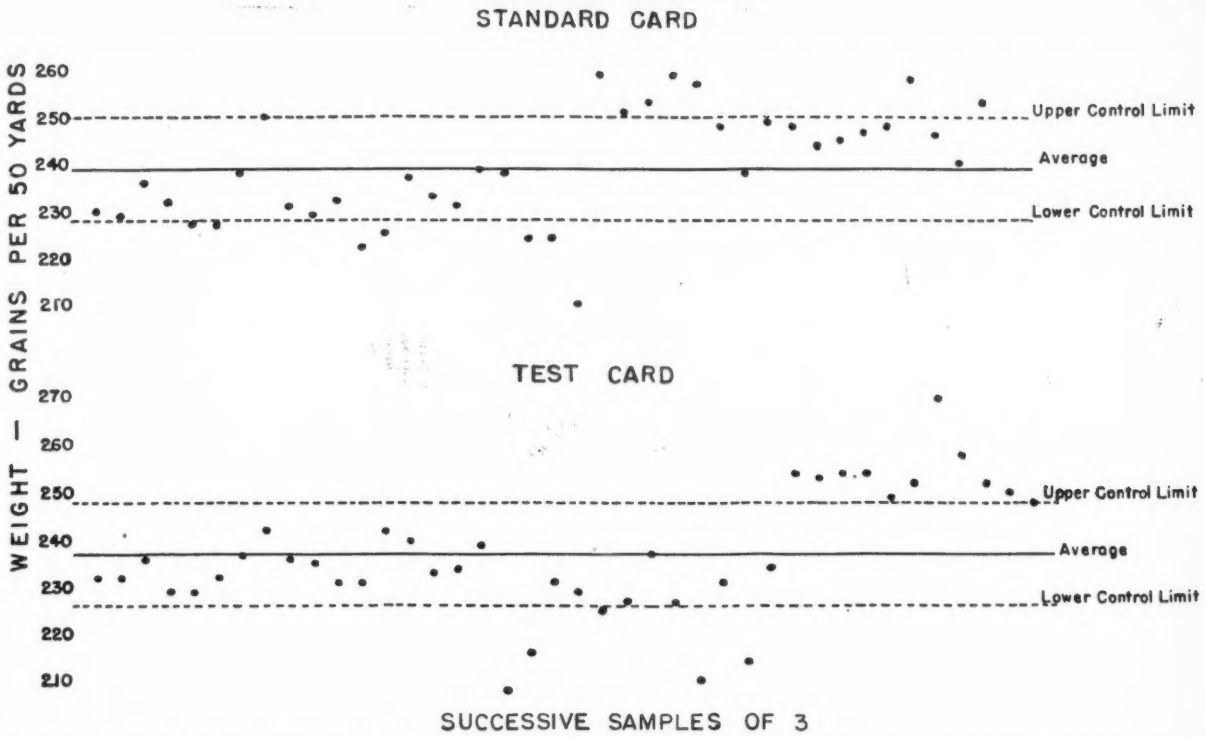

Fig. 2. Control chart for averages. Comparison of output quality of a standard card with that of a card equipped with special attachment for improving the quality of roving.

equipment which the machinery makers promote as being more efficient and producing better quality than older models. Frequently a new machine will be installed for a trial period in a mill and its performance compared with that of the old. The evaluation of productivity of the new equipment compared to the old is generally a relatively simple problem, but the evaluation of quality may be very complex, particularly in carding and spinning equipment. In such cases the control chart technique of presentation and interpretation of data is very helpful.

A knowledge of quality control chart methods facilitates the planning of the comparison. The principles to follow in sampling are emphasized in discussions of the control chart technique, the use of rational subgroups, frequent small samples instead of infrequent large ones, the grouping of data on the basis of the order of production. The amount of data to collect in determining whether a state of control exists, the criteria to use in judging the data and their calculation are all familiar to quality control workers. These principles form a framework in which fit many problems of comparison in applied textile research. Use of them reduces the amount of time that need be spent in planning and executing a comparison and it insures efficient use of the data obtained. An example will help to illustrate this.

Recently a carding attachment for improving the uniformity of roving was installed on a trial basis at the Alexander Smith and Sons Carpet Company. The output quality of the card so equipped was compared with that of the card adjacent to it which was judged to be the same in all respects as the test card except that it was not fitted with the attachment for improving uniformity. The measure of uniformity was the collective weight of the ends of roving from a spool, the sample being of such length as to give 50 yds. of roving. The weighings were made after being conditioned in an atmosphere of 65% R.H. and 70° F. temperature.

One roving spool from every doff was sampled on both cards. This spool was always the No. 2 spool in the bank of four spools produced by the card. From each spool three roving samples were taken. Each group of three constituted the rational subgroup, that is, a group of observations taken from a portion of production all of which could be considered as having been made under essentially the same conditions. The test was run for one week because in this time sufficient data would have been collected to show control if it existed and the effects of changes in atmospheric conditions would have an opportunity to influence the performance.

Both cards were run on the same lot of stock and the condition of the stock in the card feed as to moisture and oil content was checked throughout the test to ascertain that both were receiving essentially the same material. At the beginning of the test both cards were set to give the same weight of roving and this setting was unchanged throughout the test. The feeds of each card were kept at the same levels. Each group of three observations was averaged and the range within each group of three determined. Figures 2 and 3 show control charts of the average and the range for the test and standard cards, respectively.

The charts for averages show lack of control. No difference between ma-

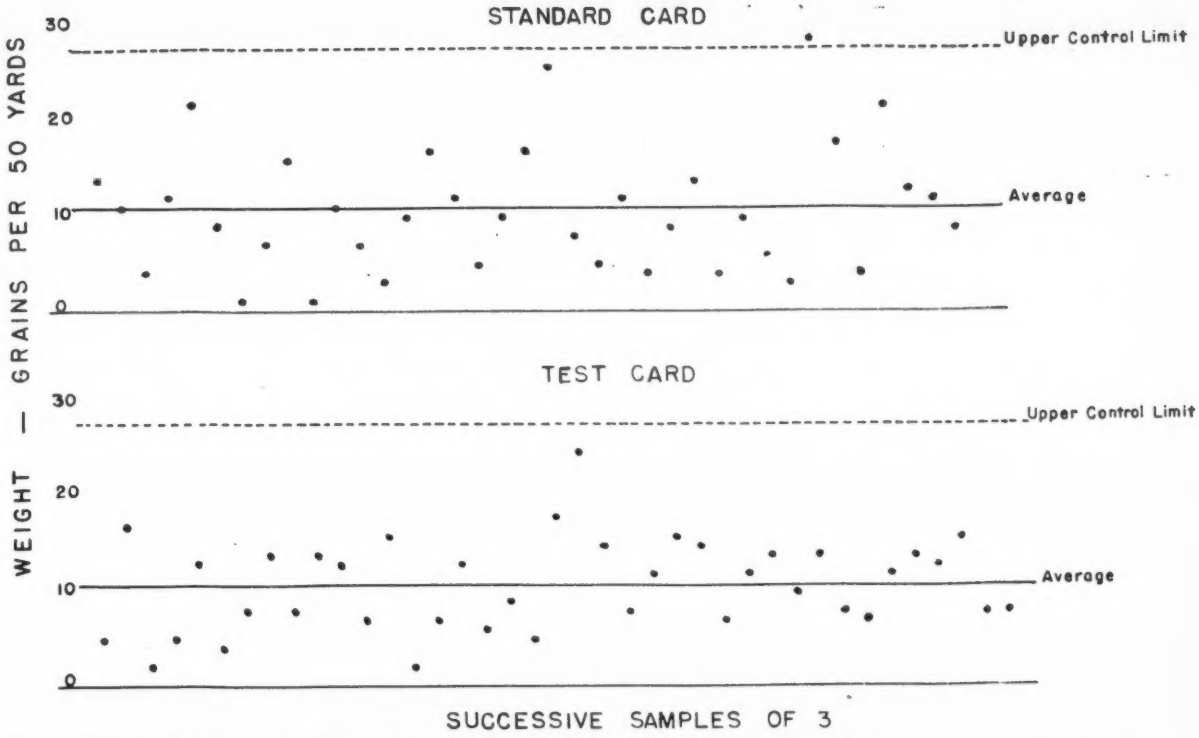

Fig. 3. Control chart for ranges. Comparison of output quality of a standard card with that of a card equipped with special attachment for improving the quality of roving.

chines is noted in this respect; both have similar patterns of wide fluctuation. Control limits aren't necessary to reach this conclusion, but their spread is helpful as a quantitative measure of the allowable variation in each card's performance.

The reason for lack of control was believed to be changes in atmospheric conditions which were marked during the test period. The card room, where the test was run, was humidified but not controlled at one level.

The range charts show control for each machine. The average range and the spread of limits is the same for each card. Thus the data and the charts demonstrate that the attachment for improving uniformity does not give more even roving on the test card than the one not so equipped.

The control chart for range (or standard deviation) is of considerable importance in comparisons of this nature. If the equipment being studied did make more uniform roving this would not have been readily reflected by simply plotting averages since each card is equally affected by humidity changes. However, the chart for ranges would have pointed out this fact if it was so. Within the time taken to make a roving spool the humidity is essentially constant so that had the test equipment been effective the range of weights on any one spool would have been less than the range for the corresponding spool on the other card.

While this conclusion might have been reached by merely tabulating the corresponding values of range from each machine, knowledge of whether one or both machines meets the criteria for uniformity (falls within control limits) is important in the judgment of the equipment. If the test card gave a lower average range of roving weight within a spool than the standard card but did not meet the criteria of reproducibility, then there is no assurance that the test card will maintain the lower average range in the future. If such a condition had occurred in this comparison we might have concluded that the carding attachment showed promise of improving uniformity but further development should be carried on until controlled range data were obtained.

The control chart for range, then, prevents us from rejecting equipment which does give greater uniformity, but which can not be demonstrated by a comparison of average weights alone because of the influence of test conditions impossible to control, in this case humidity. It does not seem exaggerated to say that a person employing control chart methods in such comparisons would more often arrive at a truer picture of the relationship between two machines than one who does not.

The use of quality control chart techniques in applied textile research can not take the place of creative imagination, ingenuity and technical skill. But it can increase a research worker's efficiency and effectiveness by providing self criticism of his own work and by providing principles and a course of action in the often recurring problems of comparison of materials and machines.

Selected Ordinate Method for Interpretation of Spectrophotometric Data*

By E. I. STEARNS

Summary

In an effort to standardize the selected ordinates for use in interpreting spectrophotometric data to determine if camouflage samples pass U. S. Specifications 100–12, the basis of the calculation of a proposed set is presented.

The curve plotted by the spectrophotometer [1] [1] showing the percentage of each of the rainbow colors which is reflected by a sample, can, by a slight modification [2], be made to extend beyond the visual range and include some data in the near infra-red.

One of the advantages of spectrophotometric data is that they are fundamental in nature and from them other data of interest can be calculated. For example, by colorimetric methods of interpretation [3], the appearance of a cloth sample when viewed by a normal observer under standard daylight conditions can be predicted. To facilitate these calculations, if no mechanical integration is available, it is customary to use a set of selected ordinates as the first step in the calculation. This process is the addition of the reflectance values at certain prescribed wave-lengths.

It is also well recognized [4] that the same mathematical methods may be used to predict how a sample will affect a photographic negative. Because in wartime the military forces include among their methods of camouflage detection photography in the near infrared region, the procurement of U. S. Army camouflage materials includes Specification 100–12. This calls for a photographic test. It is only natural, therefore, that when the photographic qualities of a sample became important those laboratories equipped with spectrophotometers used the data to predict the results of the photographic tests.

Measuring the sample on the spectrophotometer takes about five minutes, and summing the ten reflectances takes about two minutes so that in an elapsed time of seven minutes it can be determined if a sample passes the specifications. To carry out the photographic test, involving exposure, development of negative, drying, and measuring on a densitometer, requires several times longer. While it would not be economical to buy a spectrophotometer for this purpose only, it is economical to use it

* A contribution of the Research Department, Calco Chemical Division, American Cyanamid Company, Bound Brook, New Jersey.

[1] Figures in brackets represent literature references at the end of this paper.

for this purpose if it is already available.

The selected ordinates for use in calculating visual appearance are well established, and when this kind of interpretation is desired, one has merely to consult the literature for the correct values. However, the selected ordinates for use in calculating photographic response in accord with specification 100–12 are not formally accepted by an authoritative body. Consequently the various laboratories using this method have calculated their own sets of ordinates. Two such sets have been published [5, 6] and they differ slightly. Unpublished ordinates in use in other laboratories differ from these two.

The present situation is that several sets of ordinates are in use, and while the differences resulting therefrom may be slight, it would seem appropriate to propose a set for general adoption. The purpose of the present article is to present detailed calculations of a set of proposed ordinates with the hope that the various interested laboratories can agree upon a single set for universal use.

Photographic Specifications

Briefly outlined, specifications 100–12 call for photographing the sample on the equivalent of Eastman Infra-red Safety Sheet Film, using a Wratten 89A filter and illuminating uniformly with standard incandescent light bulbs from a 45° angle. The film is to be developed according to the manufacturer's recommendation and the negative examined for comparison of densities of sample with standards.

It might be argued that the spectrophotometric test involves different viewing conditions than the photographic and therefore does not give a reliable indication. However, this is not related to the choice of ordinates for calculation.

The light specified is "standard incandescent lamp bulbs." The distribution of energy from tungsten filament lamps varies depending on the voltage of the lamp, the age, and other factors. The closest thing to a standard is probably a tungsten lamp operating at 2848°K, which corresponds to the tungsten lamp adopted as standard by the I.C.I.[3]. The relative distribution of the energy from this lamp has been calculated from Planck's Law assuming constant emissivity. These data are plotted in Figure 1 curve A and are tabulated in Table I, column A.

The filter specified is a Wratten No. 89A. Wratten filters are known to vary somewhat. The Eastman Kodak Handbook of Wratten Light Filters specifically warns that their "Transmission data . . . should not be used . . . as representing precisely . . . a particular filter." In practice, this variation is so small that for commercial testing of camouflage samples it is unimportant. The transmission of this filter as given in the Wratten Light Filter Handbook extends only as far as 700 mμ. In order to get the transmission in the infra-red the transmissions of two separately procured filters were measured on a spectrophotometer. The relative transmission is plotted in Figure 1 curve B and tabulated in Table I, column B. The data agree reasonably well with the Wratten Handbook data from 680–700 mμ and

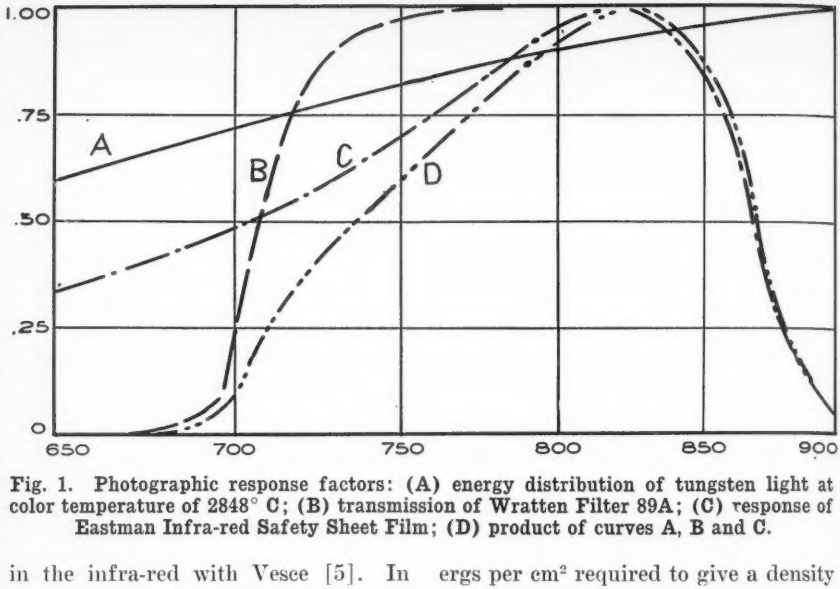

Fig. 1. Photographic response factors: (A) energy distribution of tungsten light at color temperature of 2848° C; (B) transmission of Wratten Filter 89A; (C) response of Eastman Infra-red Safety Sheet Film; (D) product of curves A, B and C.

in the infra-red with Vesce [5]. In any event, the variations introduced in the photographic tests in the various laboratories due to filter variation is no greater than the variation introduced in the present calculation by use of these particular values.

The film specified is Kodak Infra-red Sheet Film. The linear response curve of this film has been calculated from the logarithmic data supplied through the courtesy of Dr. L. A. Jones of the Eastman Kodak Company. The difficulties of arriving at a significant average curve are expressed in a letter from Dr. Jones, from which we quote, as follows:

"In response to your request we are submitting herewith a curve showing as a function of wave length the logarithm of the sensitivity of the Kodak Infra-red Sheet Film when developed in D–19 for 5 minutes at 68° F. Sensitivity is defined as the reciprocal of the exposure, expressed in terms of ergs per cm^2 required to give a density of 1.0. The exposure time used in obtaining this curve was 15 seconds. The effect of increasing or decreasing the exposure time is to decrease or increase the sensitivities for all wave lengths proportionately. The relation between exposure time and sensitivity is not a linear one and hence it is impossible to give a simple rule for computing the sensitivity function for exposure times other than the one which was used in obtaining these data.

"We wish to point out, and suggest that you lay emphasis on this point in your article, that the U. S. Army Specification 100–12 does not define exposure conditions precisely. Hence the density value on which the submitted sensitivity curve is based had to be chosen quite arbitrarily. Photographic comparisons made at much higher or lower densities (which are not excluded by Specification 100–12) can give results appreciably different

Table I.—Response characteristics

λ	A RE 2848°	B Relative trans. 89A	C Rel. Sens. IR Film	D	E	F Selected Ordinates
650	59.5	0	33.1	0		
660	62.0	0	35.5	0	0	
670	64.5	0	38.0	0	0	
680	66.7	1.0	41.7	0.3	0.3	
690	69.3	4.0	44.7	1.3	1.6	
700	71.5	23.0	47.9	8.5	10.1	
710	73.6	58.0	52.5	24.5	34.6	
720	75.8	80.0	55.0	36.2	70.8	723
730	78.0	90.0	58.9	45.0	115.8	
740	80.1	94.0	64.6	52.9	168.7	749
750	82.0	97.0	69.2	59.7	228.4	
760	83.8	98.5	74.1	66.4	294.8	768
770	85.5	99.5	79.4	73.4	368.2	784
780	87.4	99.5	85.1	80.5	448.7	
790	88.8	99.5	91.2	87.5	536.2	799
800	89.9	99.5	95.5	91.7	627.9	812
810	91.0	99.5	97.7	96.2	724.1	
820	92.4	99.5	100.0	100.0	824.1	825
830	93.5	99.5	97.7	98.7	922.8	838
840	93.3	100.0	93.3	96.1	1018.9	852
850	96.0	100.0	83.2	86.7	1105.6	
860	96.8	100.0	70.8	74.5	1180.1	870
870	97.5	100.0	42.7	45.1	1225.2	
880	98.5	100.0	21.9	23.4	1248.6	
890	99.3	100.0	10.5	11.3	1259.9	
900	100.0	100.0	5.0	5.4	1265.3	

λ = wavelength in millimicrons of response data
A = relative energy of "light" from a tungsten lamp with a color temperature of 2848° (ergs/sec cm²)
B = relative transmission of Wratten Filter 89A (highest transmission taken as 100)
C = relative response to "light" of Eastman Infra-red Safety Sheet Film (sec. cm²/ergs) exposed and developed under conditions outlined in letter of L. A. Jones
D = product of A, B, C
E = running sum of D
F = selected ordinates

from any calculation based on the sensitivity curve for D = 1.0. In our judgment, densities actually encountered in photographic tests carried out as prescribed in Specification 100–12 should average about 1.0 and discrepancies between the photographic and computed results should be less severe than if any density appreciably different from 1.0 were used for the definition of spectral sensitivity. Some discrepancies are unavoidable because of the variations of gamma with wave length. The best that can be done is to minimize the discrepancies and we believe the enclosed curve for D = 1.0 will accomplish this as well as a curve obtained on any other basis.

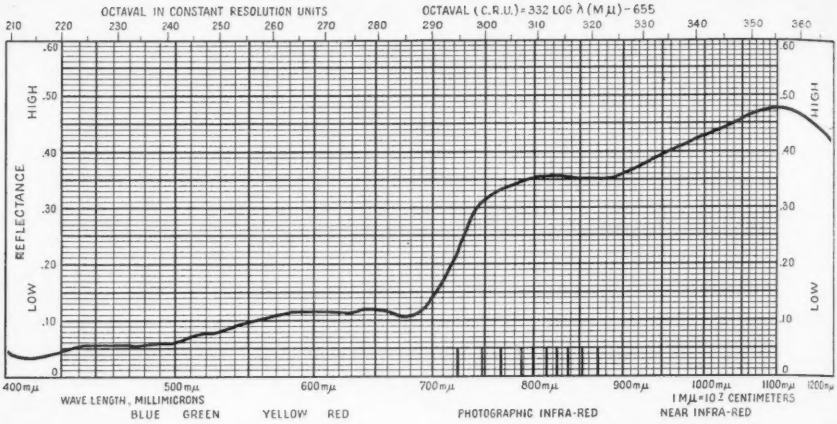
OCTAVAL IN CONSTANT RESOLUTION UNITS
OCTAVAL (C.R.U.) = 332 LOG λ (Mμ) − 655
210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 360
REFLECTANCE
HIGH
LOW
.60 .50 .40 .30 .20 .10 0
400mμ 500mμ 600mμ 700mμ 800mμ 900mμ 1000mμ 1100mμ 1200mμ
WAVE LENGTH, MILLIMICRONS
1 Mμ = 10 Z CENTIMETERS
BLUE GREEN YELLOW RED PHOTOGRAPHIC INFRA-RED NEAR INFRA-RED

Fig. 2. Calculation of Sample. Complete visual and near infra-red spectrophotometric curve of a piece of burlap camouflage material colored Earth Brown (Sample 109). The average reflectance at the ten indicated wavelengths gives the "photographic reflectance." Similar calculations for the Munsell Standards give their "Photographic reflectance." By interpolation the result of a photographic test is predicted.

Table II.—Correlation data. Position in Munsell scale

Sample	Color	Photographic Test	Selected Ordinate Test
1	Light Green	6.5–7.0	6.5–7.0
2	Earth Brown	6.0–6.5	6.0–6.5
3	Light Green	6.5–7.0	6.5–7.0
4	Dark Green	7.0–7.5	7.0–7.5
5	Black	3.0–4.0	3.0–4.0
6	Loam	3.0–4.0	3.0–4.0
7	Earth Red	6.0–6.5	6.0–6.5
8	Olive Drab	6.0–6.5	6.0–6.5
9	Earth Yellow	7.0–7.5	7.0–7.5
10	Earth Brown	6.0–6.5	6.0–6.5
11	Field Drab	7.0–7.5	7.0–7.5
12	Sand	7.0–7.5	7.0–7.5
13	Dark Green	6.0–6.5	6.0–6.5
14	Dark Green	6.0–6.5	6.0–6.5
15	Dark Green	6.5–7.0	6.5–7.0
16	Dark Green	6.5–7.0	6.5–7.0
17	Dark Green	7.0–7.5	7.0–7.5
18	Dark Green	7.0–7.5	7.0–7.5
19	Dark Green	7.0–7.5	7.0–7.5
20	Dark Green	7.0–7.5	7.0–7.5

"We wish to emphasize that the curve enclosed represents what we consider to be the average of the current product. As you doubtless realize, there are certain unavoidable variations from batch to batch in any photographic material. You should be very careful, therefore, in your own usage of these data and in discussing them, to point out that the curve should be considered only a reprentative spectral sensitivity curve. High precision measurements made on other samples might possibly show small variations from the data incorporated in this curve."

The camera and lens do not introduce an appreciable change in the sensitivity response and therefore do not affect the selection of ordinates.

The standards of comparison are Munsell Gray Scale reflectance standards. The nature of these does not affect the selection of ordinates.

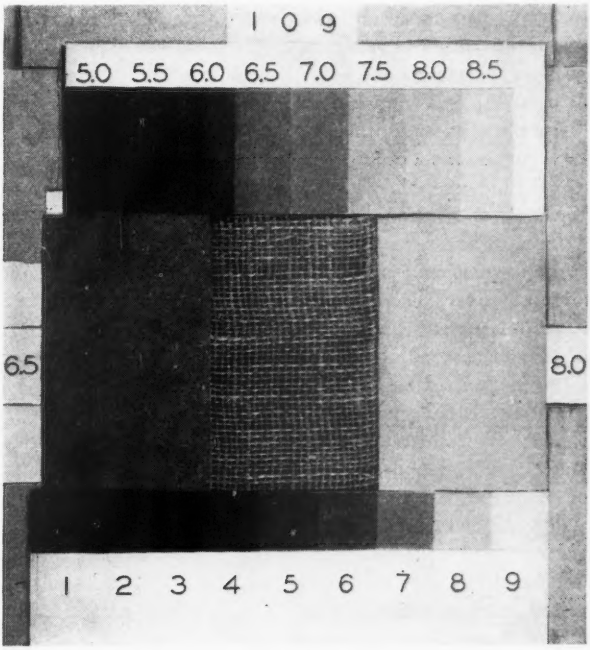

Fig. 3. Photographic test. The burlap sample of Earth Brown (Sample 109) is in the center. The series of squares labeled 1 to 9 is a full step Munsell Gray Scale. The series of rectangles labeled 5.0 to 8.5 is a half step Munsell Gray Scale. On each side of the sample are two large Munsell standards, 6.5 and 8.0. The 109 is the photograph and sample identification number.

Calculation of Ordinates

In Figure 1 are presented three curves, A, B, C, which form the basis

for the calculation of the ordinates. The data are also presented in numerical form in Table I. Any improvement in selected ordinates must result from an improvement in these data, that is, a slightly different curve which is more representative of the lights in actual use, or the filters in actual use, or the film and exposure times in actual use. The difference in the ordinates reported by Vesce [5] and the ordinates reported by Stearns [6] and those calculated here arise from using different film sensitivity curves.

To predict a photographic density relative to the Munsell Standards it is necessary to multiply the reflectance of the sample by Curve D and integrate the area under the curve. The accomplishment of this mathematical process by a method of selected ordinate integration and the method of calculating the selected ordinates is fully explained in the Handbook of Colorimetry [3] for calculating visual response. The same method applies here. The selected ordinates of Table I are obtained in this manner.

Extreme accuracy in the calculations is not warranted because variations in experimental conditions of actual cases result in some randomness of the photographic tests. Consequently the spectral characteristics as given in Table I are listed only at each 10 mμ interval and selected ordinates are calculated by interpolation linearly to the nearest one mμ.

The units of curve A, Figure I, are ergs/sec $\times$ cm^2. The units of curve B, Figure I, are the reciprocal of this. Curve C has no units. Thus the product of curves A, B and C is a relative response. This is curve D.

Practical Application

In use, the reflectance of the sample is measured, the reflectance at each of these ten wavelengths is averaged, and the result is a relative photographic response. While individual procurements of Munsell Standards will vary somewhat in their photographic response, the official standards are as follows: 56.6% for N/8, 37.4% for N/6.5 and 25.7% for N/5.5. Therefore, if the specifications call for the sample to fall between N/8 and N/6.5, the average reflectance at the selected ordinates must be between 56.6 and 37.4%.

Figure 2 shows the reflectance of a typical camouflage sample. The average of the reflectance is found to correspond to a position between Munsell 6 and 6.5. Tested photographically, as shown in Figure 3, this sample again tested between 6 and 6.5. The agreement between these two methods of test on a number of samples is indicated by the data of Table II.

The writer is indebted to Dr. D. L. MacAdam of the Eastman Kodak Company for checking the selected ordinate calculations.

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2. Stearns, E. I., *J. Opt. Soc. Amer.* **33**, 27 (1943).
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Experiments in Treating Cotton Batting with Hevea Latex Point Way to

Control of Continuous Processes

By EARL K. FISCHER*

Experiments designed to determine the variables which affect the absorption and retention of Hevea latex in fibrous batting revealed that the following are of paramount importance: (a) total nonvolatile content of the bath; (b) wetting time and its control through the addition of surface-active agents; and (c) squeeze-roll pressure. Although the use of Hevea latex for treating batting is not a common textile-mill process, it is believed that the following resumé of the experiments will be of interest to all textile men concerned with the control of continuous operations in which a web of material is immersed in a saturating bath, subjected to pressure between rolls, and dried.

Wetting of a fibrous material by any liquid is generally facilitated by conditions which favor low contact angle of the wetting liquid on the solid. It is common practice, for example, to scour cotton with alkali to remove the naturally present oils on the surface of the fiber. Cotton processed in this way is highly absorbent for aqueous solutions and suspensions. A similar result may be achieved by adding substances to the aqueous system which strongly lower the surface tension of the solution [3].[1] The textile industry has long used turkey red oil and sodium soaps; more recently a myriad of synthetic compounds comprising the class of commercial surface-active agents has become available.

For the wetting of a fiber or surface, it is sufficient in most cases to have a limiting minimum of surface-active material present to effect adequate penetration and spreading; excess of reagent is not objectionable except as regards cost. With a more complex process, such as the impregnation of cotton batting with rubber latex, however, initial wetting of the fiber is not alone a sufficient condition, for the fibers must retain the impregnating material uniformly distributed throughout the reticulum or network during drying and other manufacturing operations. When an excess of surface-active agent has been added to the aqueous suspension, passage of the web through squeeze rolls to remove excess saturant, together with the capillary effects of surface drying modify the distribution of the dispersed phase in the web. Some

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[1] Figures in brackets indicate literature references at the end of this paper.

of the factors to be considered in latex impregnation processes have been noted in the literature [5, 6, 11, 12], and a compilation of all the patent art has been given in the extensive work of Marchionna [10]. Specific data on the physical chemistry of the impregnation process appear to be lacking, however.

Experimental Details

Hevea latices were obtained from several suppliers. They were ammonia-preserved normal latices, standardized to a total solids content of 38–40%. Analysis as given by Kemp [8] was representative. Rubber hydrocarbon was 35–36%, with the non-rubber components contributing to the remainder of the total solids. Concentrated latex of 60% total solids was the product obtained by centrifuging normal latex. The skim latex used contained 20% total solids.

Cotton battings were prepared from napper, comber, and China cotton, and scoured materials. The napper cotton was a waste product with short fibers (av. 0.4 inch). Some experiments were performed also with jute batting, part-cotton felts, and absorbent papers.

Surface-active agents tested included a variety of commercial products recommended for latex compounding and included the sodium salt of mixed fatty alcohol sulfates, the sodium salt of an aryl-alkyl sulfonate, mono-amyl ammonium ricinoleate, turkey-red oil, and chip soap.

Although the manufacturing process called for additional ingredients in the latex bath (vulcanizing agents, accelerators, softeners, etc.) the experiments described here were on the basis of the minimum of ingredients in order more effectively to isolate the effect of each variable. Dilution of the latex was made with 2% ammonium hydroxide solution. All additions to the latex were made in the form of solutions or suspensions in order to prevent localized coagulation.

Wetting times for battings were determined by placing a piece of the cotton in a tray, covering with a metal screen, and holding the batting submerged with the screen at the surface [11]. The time required for the latex to penetrate to the surface was noted as wetting time. This method led to fairly consistent measurements and good check determinations could be made with practice. The advantages of this test, aside from its simplicity, were the following: (a) tests could be made quickly; (b) the batting was not mutilated; (c) the procedure simulated machine processing; (d) long exposure to air with consequent skinning of the latex was avoided.

Surface-tension determinations were made by the ring method using the duNouy Tensiometer calibrated by the procedure outlined by Macy [9]. Precision of the measurements was sufficient to reproduce readings to less than 0.5 dyne; the values obtained were within the accuracy of recorded surface-tension data for latices [2, 7].

The hand-saturating technique was adapted from the principle of the factory machine. The cotton batting or other material was placed between tin-plated screens which overlapped the swatch by about an inch at the edges, and the whole was then immersed in a photographic tray containing the latex bath. The screen was rolled slowly with a two-inch steel roll for the time necessary to obtain thorough wetting.

TABLE I. Surface tension data hevea latices.

Latex	Rubber or Total Solids %	Surface Tension Dynes/cm.	Reference
Normal	30(TS)	35.6–35.9	7
Fresh (Plantation)	35(RS)	40.5	2
Fresh (−1.15%NH_3; age 1 day)	35(RS)	40.5	2
Same (Age 10 months)	35(RS)	35.5	2
Concentrate ("A")	40(TS)	31.9–32.2	7
Concentrate ("B")	40(TS)	35.9–35.7	7
Normal (Fresh)	—	38 –40	12
Normal (Preserved)	—	ca. 35	12
Concentrate	60(TS)	40 –42	12
Concentrate (0.5% alkalinity)	60(TS)	42.3*	11

*Temperature 19.3° C. Other measurements presumably 25–30° C.

TABLE II. Surface tension data on diluted, skim, and formulated latices.

Latex	Total Solids %	Surface Tension Dynes/Cm.
Normal (Preserved; age 6 months)	40	36.4
Diluted normal*	30	36.3
Diluted normal*	20	38.4
Diluted normal*	10	40.8
Diluted normal*	5	41.7
Diluted normal*	1	47.0
Skim	20	37.7
Compound A (Commercial impregnating formula)	33	33.5
Compound B (Commercial impregnating formula)	30	35.6

*Dilution with 2% ammonium hydroxide.

The saturated sheet with its protecting screens was then passed through the rolls of a hand wringer. The wet swatch was dried in an oven at temperatures which ranged for experimental purposes between 120 and 200° F.

Impregnation Variables

The art of textile processing appears to lean toward quick wetting as the prime requisite, but this criterion alone is inadequate for control. Corollary effects of wetting conditions for the latex-batting system include the differential extraction of serum components of the bath (including surface-active agents in solution), migration of the rubber to the surfaces of the sheet on drying, and the total rubber content of the finished sheet.

Wetting time and surface tension. Surface tension data for latices given in the literature are assembled in Table I. The fresh latex is stated to have a surface tension of about 40 dynes per cm. After treatment with ammonia this value drops slowly until a low of around 35 dynes per cm. is reached. The commercial samples received in this country were of variable age after ammonia preservation, and most samples examined were in the range of 36 to 38 dynes per cm. The surface tension increase on dilution with 2% ammonium hydroxide is shown in Table II for a latex reported to be 6 months old at the time of testing. Skim latex, relatively rich in the non-rubber components, had a surface tension of 37.7 dynes per cm.

These values are about 10 dynes above the surface-tension values obtainable with dilute solutions of synthetic surface-active agents [3]. The addition of these reagents to latex has been discussed by Noble [11] and others [1, 5]. Some reagents reduce the surface tension to values slightly under 30 dynes per cm., but the majority fall in the range of 30 to 34 dynes per cm. This decrease in surface tension of roughly 5 dynes was observed to correspond to a three- or four-fold decrease in wetting time. Thus, where normal latex, diluted to

10% solids required 35 seconds to wet through a thin batting (4 oz. per square yard), the addition of any one of five different surface-active agents reduced the wetting time to an average of 6 seconds.

Comparison of the wetting time and surface-tension values for normal latex diluted to 30% solids is shown in Figure 1. It will be noted that as the surface tension increases from 37.5 dynes per cm. to 40.5 dynes per cm., the wetting time for napper cotton batting (7 oz. to the sq. yd.) is tripled —15 to 45 seconds. The extraction of the surface-active materials in the latex is indicated also, for the abscissa of the curve represents the number of pieces or swatches of cotton saturated in one bath without replenishing the latex.

The relation between wetting time and surface-tension is also shown in Figure 2. Curve A in this figure shows the depletion of the surface-active materials by repeated saturation cycles; curve B shows the effect of a surface-active agent added to the depleted bath. The addition of the reagent does not restore the same wetting qualities to the bath as shown by the displacement of the two curves. If the surface-active agent had been equivalent to the serum components for this case, the curves would have been superimposed, but a lower surface tension is required for a given wetting time than is characteristic of an undepleted bath of latex with its full complement of serum components. The spread between the two curves represents, of course, a greater divergence than would be found in a normal manufacturing operation where fresh latex is continually added to maintain the correct bath volume.

Surface-tension data do not supply a direct measure of the wetting of a solid surface by a liquid. Solid-liquid wetting relations can be estimated only by indirect methods. Interfacial tension measurements on the aqueous solution and a selected oil are sometimes made as an alternative procedure, with the assumption that the solid (in this case cotton or other fiber) is coated with oil and that the liquid-liquid interface thus represents a closer approximation of the solid-liquid system. Surface-tension data, however, usually parallel interfacial tension data on inert oils and supply useful though incomplete information on the penetration of porous solids by liquids.

Differential extraction. Surface-active materials appear to be preferentially adsorbed by the batting. The non-rubber components, such as proteins, resins, and added surface-active agents, are extracted at a rate greater than the rubber, resulting in a comparative enrichment of rubber in the bath and depletion of the water-soluble materials. This results in a gradual increase in wetting time and surface tension with an accompanying change in rubber content of the sheet. Differential extraction of this kind is analogous to the change in composition of a dyebath during processing.

This effect is illustrated in Figure 3 where the wetting qualities of the bath are shown as a function of the squeeze-roll pressure and the solids retained by the batting. The quantity, "% of theoretical solids," was obtained by the following computation:

$$\% \text{ Theoretical Solids} = \frac{\text{Solids in Dried Sheet}}{\text{Solids Calculated from Latex Absorbed in Wet Batting}}$$

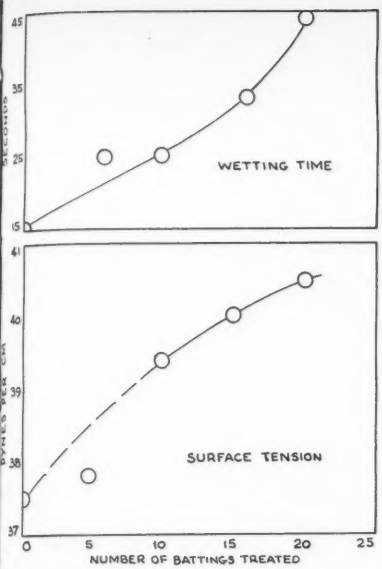


Fig. 1. Change in wetting times and surface-tension values on bath depletion.

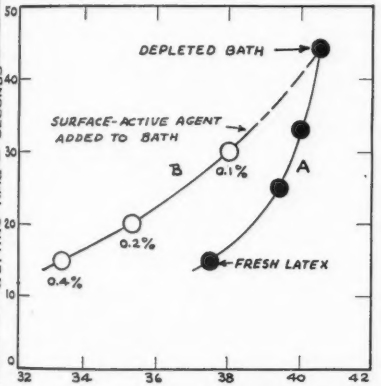


Fig. 2. Depletion of latex bath and partial restoration of wetting qualities by addition of a surface-active agent. (Napper cotton batting; 30% latex; sodium salt of fatty alcohol sulfates as wetting agent.)

It will be noted that the latex baths of the higher surface-tension values retained a larger proportionate amount

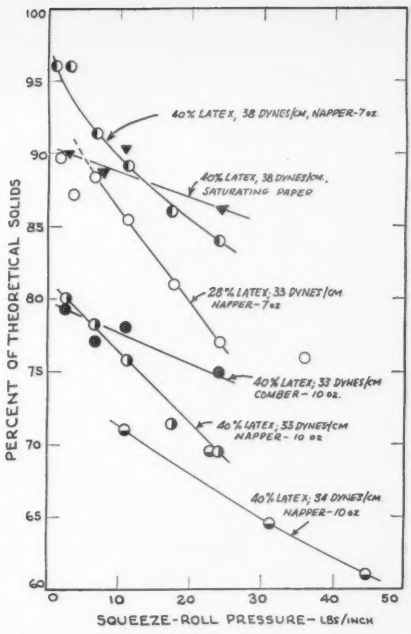

40% LATEX, 38 DYNES/CM, NAPPER-7 oz.
40% LATEX, 38 DYNES/CM, SATURATING PAPER
28% LATEX; 33 DYNES/CM NAPPER-7 oz
40% LATEX; 33 DYNES/CM COMBER - 10 oz.
40% LATEX; 33 DYNES/CM NAPPER- 10 oz
40% LATEX; 34 DYNES/CM NAPPER-10 oz
PERCENT OF THEORETICAL SOLIDS
SQUEEZE-ROLL PRESSURE- LBS/INCH

Fig. 3. Differential extraction of serum and rubber solids for various latices and base materials as a function of squeeze-roll pressure.

of the latex solids and at low squeeze pressures approached values from 90 to 96%. At lower surface-tension levels, the maximum retained was around 80%. As the squeeze pressure was increased, there was a striking trend in all cases to lower percentages. Data on a variety of bath concentrations are presented in Table III. In these experiments, squeeze-roll pressure was not measured, but was estimated as being in the range of 4 to 8 lbs per inch. It will be noted that dilution of the latex corresponded with an augmented differential-extraction effect.

Supplementary information obtained from other experiments showed that the differential extraction of the water-soluble components was increased also by

TABLE III. Impregnation of cotton batting.

Latex Concentration %	Surface Active Agent	Surface Active Agent Concentration % on Bath	Wetting Time (Seconds)	Surface Tension Dynes/cm.	Rubber in Dried Sheet %	% of Theoretical Rubber
40	None		20–25	38	55	86
40	A	0.2	10	33	55	78
40	A	0.2	10	33	52	75
40	C	0.5	10		50	66
30	None	—	30	36	44	82
30	A	0.2	—	34	49	74
30	A	0.4	—	33	52	70
33	Unknown*		10	33.5	46	73
20	None	—	30	39.2	40	83
20	A	0.4	10	36	36	66
20	C	0.5	9		33	65
15	None	—	60	ca. 39	35	92
14	A	0.5		35	26	66
15	B	1.0	7–8	32	24	52
15	D	1.0	7–8	32	26	49

* Commercial impregnating bath.
A—Na salt of fatty alcohol sulfates.
B—Na salt aryl-alkyl sulfonate.
C—Turkey red oil.
D—Monoamyl amine ricinoleate.

TABLE IV. Gradient of impregnated batting (12 oz. napper cotton batting).

Bath Concentration %	Rubber Solids Content, %	
	Inner ply	Outer Plies
34.3	34.0	34.6
38.5	38.8	40.6
39.5	38.4	40.0
39.6	39.5	41.1

multiple passes through the squeeze rolls, as well as by the use of thick and highly compressible battings.

These observations were made on deflocculated, dispersed systems. When flocculation of any component of the bath is present, filtration effects overshadow all others. It is likely, too, that the water-soluble components are extracted at differential rates with respect to each other and to additives, such as stabilizers and surface-active agents.

Concentration of rubber on surfaces of dried sheet. The amount of rubber in the form of latex particles transported to the surfaces during drying is proportionate to the quantity of water evaporated from the surface. With baths of low solids (10–20%) and low surface tension, the deposition of rubber on the surfaces was so complete as to leave the interior of the sheet of 0.04 inch thickness completely devoid of rubber. This condition leads to an easily split sheet.

A second factor contributing to surface deposition of solids is the retention by capillarity of latex in the spaces in the screen. After compression between rolls, the latex so held is drawn into the batting as it springs back to

its normal thickness on leaving the squeeze rolls.

Deposition of rubber on the surface is objectionable for many reasons aside from splitting of the sheet and rubbery surface characteristics. Much of the rubber is wasted and the tensile strength impaired, for the rubber is not in position to bind all the fibers together.

Migration during drying was minimized by using the bath at the highest feasible solids content with squeeze pressures which would leave the requisite quantity of rubber in the dried sheet. Compensation for differential extraction of surface-active substances was accomplished by periodic additions of surface-active agents. For mill operation, casein solution was added also to supplement the surface-active agent and to approximate more nearly the characteristics of the original latex composition. Addition of skim latex, was found to provide an equivalent, rather than an approximate adjustment of the normal latex components during operation [4]. The data in Table IV indicate the probable minimum differential in rubber content of the inner and outer plies of a cotton batting after impregnation. These figures were obtained by analyses for total solids on separated plies of 12 oz. material.

Rubber content and density of sheet. The actual rubber content of the product was determined by economic and end-use requirements. The dried sheet formed from the fibrous batting was porous; densities ranged from 0.2 to 1.0, although the majority of the products were to be found in the range of 0.4 to 0.8. Subsequent treatment, such as calendering and embossing, greatly affected the final density. A photomicrograph of a microtome section of a representative product, prepared by E. F. Fullam, is reproduced in Figure 4. The impregnant, which is largely rubber, is considered to be in the form of irregular small lumps distributed throughout the reticulum of fibers, adhering in clusters to the fibers.

Fig. 4. Cross-section of latex impregnated cotton batting. Polarized light illumination (54X).

If the assumption is made that the rubber could be placed in a uniform layer on the cotton fibers rather than the random arrangement of clusters, it is possible to make an instructive calculation to show the relative weight relations of cotton to total impregnant solids. These figures are shown in Table V. It may be deduced that comparatively large quantities of rubber are necessary to form a strongly bonded matrix for this system. Tensile-strength measurements supported this view. For tensile strength in the range of 1000 to 2000 pounds per square inch, 40–50% loadings in the finished sheet were necessary. Lower rubber solids led to lowered tensile strength; excessively high loadings re-

TABLE V. Rubber content and calculated thickness of rubber layer on cotton.

Rubber Layer Thickness (Microns)	Rubber Content %
0.5	6.5
1.0	12
5.0	41
10	58

sulted in sheet properties similar to those of a poorly-formed, non-homogenous rubber film with large elongation before breaking but not greatly increased tensile strength.

The rubber solids content of dried sheets as a function of latex concentration and squeeze-roll pressures is shown in Figure 5. The loadings obtainable as a function of bath concentration are shown in a statistical chordgraph in Figure 6 for a large number of experiments.

Other effects. The wet strength of the saturated batting was decreased on the average by 15% on the addition of 0.4% fatty alcohol sulfate type of surface-active agent to an impregnating bath containing 30% solids.

Frothing of the latex was increased by the addition of surface-active agents, but the latex stability was either not impaired or was very slightly improved, with the exception of turkey-red oil which showed a distinct decrease in the stability of the latex to agitation.

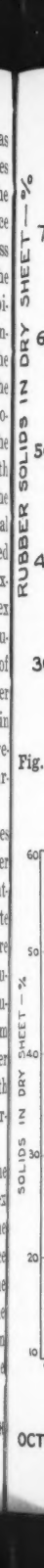
The Impregnation Process

The entire impregnation process may be visualized as follows:

When the batting is immersed in the latex bath, the aqueous solution forming the continuous phase wets the fiber surface, spreading rapidly, probably as a duplex film. The latex particles follow the stream and encounter the matted fibers at the batting surface which act as a coarse but nevertheless real filter. Mechanical working of the batting between screens serves to aspirate the latex into regions in the interior of the fiber matrix or where the fibers are more closely matted. The adhesion of the serum to the hydrophilic fiber is high; the adhesion of the latex particles to the fiber covered with the aqueous film is nil. When the saturated batting, entraining several times its weight of latex, is subjected to compression in the squeeze rolls, excess liquid is expressed, and the latex particles, being mobile and non-flocculated, are free to follow the flow of the expressed liquid, finding no greater hindrance to leaving the web than in entering. The serum, however, remains tenaciously adherent to the surfaces.

If, on the other hand, the serum does not effectively spread over the fiber surface, mechanical working of the batting aspirates the latex, and minute pockets or lakes of the liquid are formed throughout the fibrous reticulum. Expression of the excess saturant now takes place with the serum withdrawing from the fibers as water does on an oiled surface, carrying with it the full complement of latex particles.

In either case, however, drying the impregnated matrix of fiber and latex results in liquid streaming within the capillary spaces toward the surface where evaporation occurs. Some of the latex particles are carried with the streaming serum, and the concentration of rubber is increased above that in the



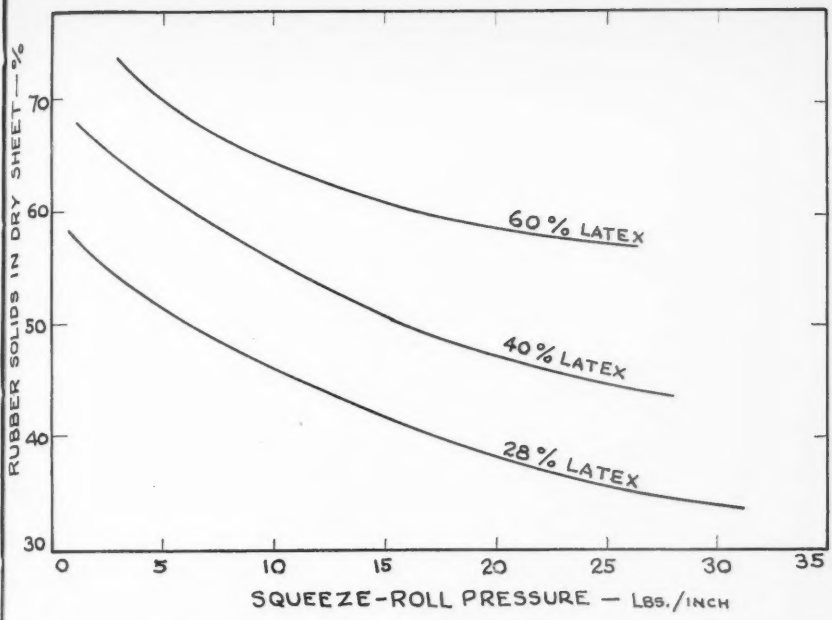
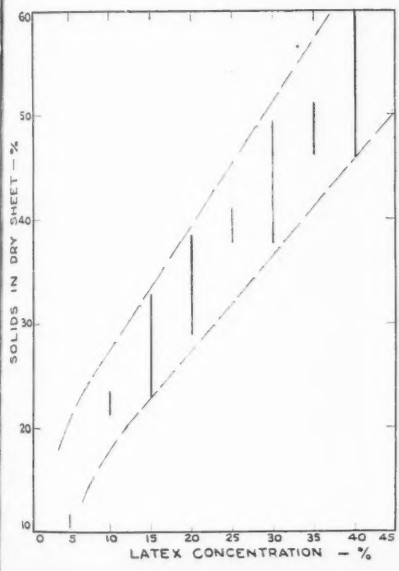


Fig. 5. Relation of rubber-solids content of impregnated batting to bath concentration and squeeze-roll pressure.



central interstices of the batting. High volume of the liquid phase (low solids content) obviously increases the quantity of latex particles transported, and the surface layering then becomes so great that the sheet is left completely devoid of rubber solids in the center. A sheet of this structure splits readily because only the matted fibers, uncemented by adherent rubber, provide mechanical bonding. With a minimum of water retained by the web, represented by a latex impregnant of high solids, there results a minimum of migration for the additional reason

Fig. 6. Relation of bath concentration to rubber solids in impregnated napper cotton batting.

that the latex coagulates when a relatively small volume of the water evaporates, and the coagulum is then trapped in the interstices of the web, unable to migrate, while the residual water evaporates. This effect is obtained alternatively by the addition of complex salts, thermally unstable, which on decomposition coagulate the latex before an appreciable volume of water has evaporated.

Summary

In the study of a continuous process for impregnating cotton batting with latex, an effort was made to isolate the important variables which affected the manufacturing operation and the quality of the product. The total amount of impregnant in the finished sheet was decreased by (a) low bath concentrations, (b) high squeeze-roll pressures, and (c) the presence of an excess of surface-active material in the bath, resulting in very rapid wetting and low surface-tension readings.

Adjustment of the bath necessitated a balance with these and other operational factors. A differential extraction of the surface-active components with respect to the rubber solids was noted. The suspension in the interstices of the batting migrated toward the surfaces on drying, resulting in a sheet which split readily. Both of these effects were accentuated by low solids in the bath and an excess of surface-active agent which gave low surface-tension measurements. Process control was accomplished by charting the surface-tension region in which adequate wetting and penetration of the batting was obtained and then maintaining the bath against exhaustion within these limits by periodic additions of a synthetic surface-active agent.

Data on this case are, of course, not generic in applicability, but analogous processes doubtless exhibit similar properties, and a theoretical picture is presented. It is suggested that control work should be based on an empirical testing procedure, which simulates the processing operation closely, and calibration of such a test in terms of fundamental physical measurements.

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RESEARCH AIDS

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* THE CHEMISTRY OF CELLULOSE. Emil Heuser. *John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. (1944), 660 pp. Price $7.50.*

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ABSTRACTS

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ANALYSIS: TESTING LABORATORY METHODS

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Abrasion Testing

Comparison of two hosiery abrasion testing machines. Margaret B. Hays and Dorothy C. Caudill. TEXTILE RESEARCH **14**, 183–87 (June, 1944).

An investigation was made of two hose constructions for resistance to abrasion and an attempt was made to determine which of two types of machines gives the more efficient test procedure. In Procedure I, toe and heel portions were tested in the circular hosiery holder of a Taber abrasion tester. In Procedure II, a machine was used designed especially to abrade the toe or heel of women's hose. Two constructions of full-fashioned hose knit from Sea Island, 1⅝ inch staple, grade 2 cotton yarns were used for comparison by each procedure. Construction A hose were made with 90/2 yarn and reinforced with a second 90/2 yarn in the heel, sole, and toe; Construction B hose from 120/2 yarns were reinforced through heel, sole, and toe with an additional end of 90/2 yarn. In this study both test procedures show that Construction A is more resistant to abrasion than Construction B and that no significant difference exists between the resistance to abrasion of the toe and heel. Procedure I required the constant attention of the operator whereas Procedure II required only intermittent work. However, the actual time of the operator was less for Procedure I because of the fact that Procedure II required 5 to 7 times as many cycles to produce a hole than were needed in Procedure I. In Procedure II the hose were abraded against a fabric whereas wheels of a fine abrasive compound were used in Procedure I.

Indivdual Fibers

A modern apparatus for determining the strength and elongation of individual fibers. Ir. V. E. Gonsalves. *Melliand Textilber.* **24**, 218–22 (May, 1943). (In German) (through *Bull. Inst. Paper Chem.* **14**, 314–15, June, 1944).

A pendulum-type tester for evaluating the tensile strength and elongation of individual fibers is described. It was developed by G. Heim and is particularly adapted to artificial fibers. Before a fiber is clamped into the tester, its denier is determined by vibroscopical measurement in a special tester, called "Vibroscope." The procedures are outlined and supplemented by illustrations.

Shrinkage of Hosiery

Device for measuring shrinkage of hosiery. Report by Textile Section, National Bureau of Standards. *Textile Research* **14** 150–51 (May, 1944).

A new device for measuring the dimensions of the feet of socks and other hosiery under different loads is described. It has proved to be of value in the study of shrinkproofing treatments and the effects of fiber and composition and methods of laundering on the shrinkage of socks.

Electron Microscopy

A bibliography of electron microscopy. II. Claire Marton and Samuel Sass. *J. Applied Phys.* **15**, 575–79 (Aug. 1944).

This is a supplement bringing up to date the bibliography published in the October, 1943, issue of the Journal and abstracted in TEXTILE RESEARCH 14, 63 (Feb. 1944). A large number of foreign papers on electron microscopy are included in this supplement.

A Laboratory Slasher

A laboratory slasher for small lots of cotton warps. John M. Cook. TEXTILE RESEARCH 14, 188–93 (June, 1944).

The author describes a laboratory slasher in operation at the U. S. Dept. of Agriculture's Clemson (S. C.) Spinning Laboratory. This machine was designed and has proved very satisfactory for the sizing and slashing of yarns in quantities spun from 5-pound test lots of cotton. It is believed that the laboratory slasher may be of interest to concerns that manufacture a large number of samples of cloth for commercial purposes, as well as to laboratories that are faced with the problem of weaving fabrics from small lots of yarn.

CHEMICAL AND PHYSICAL RESEARCH

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Cellulose Derivatives

Cellulose derivatives. Edwin C. Jahn. *Svensk Papperstidn.* **47**, 205–11 (May 15, 1944). (In Swedish; German and English summaries) (through *Bull. Inst. Paper Chem.* **14**, 351, July, 1944).

The author gives a general review of the chemistry of the cellulose derivatives, including their preparation, reactions, and properties, as well as a discussion of their utilization. On the basis of their chemical nature, the various derivatives may be divided into three groups as follows: (1) compounds which are formed by degradation, such as through oxidation and through hydrolysis; (2) compounds which are formed by loose bonds between cellulose and the reacting chemical, alkali cellulose being an example; and (3) compounds formed by typical substitution reactions, giving rise to esters and ethers. The industrial importance of the various derivatives is discussed briefly. The use of cellulose derivatives has risen greatly during the past twenty years. The principal raw material is wood cellulose. It accounts for 75% of the total cellulose used for making cellulose derivatives of all types in the United States. 38 references.

Effect of Acid on Cotton Yarn

Study of the effect of acid on the breaking strength of warp and filling threads in sheeting. C. E. Morrill. *Am. Dyestuff Reptr.* **33**, 320–1 (July 17, 1944).

A series of pieces of cotton sheeting was impregnated with C.P. sulfuric acid beginning with a 0.01 per cent concentration and increasing the concentration by 0.03 per cent with each step until a concentration of 1.0 per cent was reached. Each sample was air dried after impregnation, thoroughly conditioned, and tested for loss in tensile strength by breaking individual warp and filling yarns taken from the fabric. Under the conditions of the test both warp and filling yarns showed approximately 38 per cent loss in strength when 0.07 per cent acid was used and practically 100 per cent loss when 0.88 per cent acid was used. There was no significant difference in tendering action on warp and filling yarns.

Fluorescence

Longitudinally polarized fluorescence of fiber dyeings. Hermann Ziegenspeck. *Kolloid-Z.* **106**, 62–4 (Jan. 1944). (In German) (through *Bull. Inst. Paper Chem.* **14**, 314, June, 1944).

Ramie fiber dyed with certain fluorescent dyes (fluorochromes) shows dichroism and fluorescence totally polarized in the direction of the fiber axis.

Moisture Determination

The relationship between the moisture content of fibrous materials and atmospheric conditions. W. G. Schaposchnikow. *Melliand Textilber.* **24**, 120–1 (Mar. 1943). (In German) (through *Bull. Inst. Paper Chem.* **14**, 336 (June, 1944).

Müller, in 1882, determined isotherms for the adsorption of water vapor by cotton,

wool, silk, and flax, which indicated the relationship existing between the moisture content of the fiber and the temperature and relative humidity of the air. He developed a formula for calculating the moisture of fibers under definite atmospheric conditions which has been introduced into recent texts and recommended for practical application. The author checked Müller's data and found that his formula does not correspond to actual conditions: the difference between observed and calculated data is, in general, too great. Hence, it is not possible to apply it to practical conditions.

Glass-Reinforced Laminates

Application of glass laminates to aircraft. Capt. George B. Rheinfrank, Jr., and Lieut. Wayne A. Norman. *Modern Plastics* **21**, 94–9 (May 1944).

The successful use of glass laminates for the BT–15 airplane fuselage is disclosed and its construction described in detail. Thirteen photographs illustrate various steps in the construction. Data are given comparing the laminate with 24 ST aluminum alloy sheet. Utilization of the high unidirectional properties that can be obtained using uni-directional fabrics, where multidirectional properties are not required, results in increased strength and reduced deflections in structural components.

Forms, properties and handling of glass reinforcements. G. Slayter et al. *Modern Plastics* **21**, 100–3 (May 1944).

Many of the fundamental physical properties of glass fibers are given. In order to obtain good adhesion between glass fabrics and resins a heat treatment process has been devised during which the lubricant that is present on the glass fibers is decomposed. The ingredients of the glass lubricant are dextrinized starch, oil, gelatin, neutral emulsifier, complex amine salt and polyvinyl alcohol. To obtain adhesion between the resin and the glass fibers, certain of these ingredients must be volatilized; others must undergo a change and remain on the fibers if the textiles are to retain properties they must possess to serve as plastics reinforcement. Exhaustive tests have demonstrated that the required adhesion values and maintenance of the necessary textile properties can best be provided by heat treating the textiles. The same tests have shown that increase in adhesion caused by the heat treatment is a principal factor contributing to the high strengths obtained with glass-reinforced laminates. Caramelization of the starch in the lubricant is an easily perceptible effect of the heat treatment. The proper assembly of the fibers is necessary to attain the full benefit of the inherently good properties of glass. The results of various modifications of the fabric and laminate structure are described in some detail.

Reinforced Plastics

Impact strength of reinforced plastics. Philip M. Field. *Modern Plastics* **21**, 123–5, 162 (Apr. 1944).

Tests were conducted to determine the impact strength of reinforced thermosetting plastics, to determine the effect of elevated and reduced temperature on their impact strength, and to compare the impact strength of plastic materials with that of aluminum and cast magnesium. The samples tested were submitted by various manufacturers; they included phenol-formaldehyde and special resins reinforced with cotton, paper, asbestos, wood, or glass in various forms. The test results are tabulated. They indicate that phenol-formaldehyde and other thermosetting resins with suitable reinforcing materials can have single-blow impact strengths equal to aluminum or magnesium. The reinforcing agents producing the highest impact strength are glass and cotton cords. For the majority of materials, the strength was greater at elevated and lower at reduced temperatures. However, this trend was reversed in the case of the glass-reinforced material. A phenol-formaldehyde resin reinforced with a Mitscherlich (spruce sulfite) paper exhibited very poor edgewise impact strength.

Glass-Reinforced Plastics

Development of glass-reinforced low-pressure plastics for aircraft. Col. Paul H. Kemmer. *Modern Plastics* **21**, 89–93 (May 1944).

Complete engineering data are given for glass-reinforced plastics. These data are the results of the cooperative project between the Army Air Force, The Fiberglas Corporation, and various resin manufacturers. The data include tensile, compressive and flexual strengths, moduli of elasticity, coefficients of thermal expansion, water absorption, hardness, chemical resistance to aviation, gasoline and prestone, flammability, specific gravity, and impact strengths. Where pertinent, the data are given for tests in three directions: longitudinal, transverse and 45°. In the discussion of the data, reasons are given why a laminated plastic must have well-balanced properties in order to be used in place of aluminum alloys for aircraft construction.

Paper-Base Plastics—Effect of Moisture

Effect of moisture on the physical properties of paper base plastics. A. H. Croup. *Paper Trade J.* **118**, 43–6 (May 18, 1944).

Papers impregnated with phenolic resin were conditioned at seven different relative humidities ranging from 9 to 94.5% prior to laminating. Tests on tensile, flexural, water-absorption, dimensional stability, specific gravity and abrasion were made on the laminated material and correlated against the moisture content of the impregnated paper. In general, it was found that as the moisture content increased the tensile and flexural strengths decreased, water absorption increased, dimensional stability became poorer, impact strength was slightly improved, and that specific gravity and abrasive resistance were unchanged. If the paper-base plastic is designed for structural purposes where strength and uniformity are of major importance, the moisture content of the impregnated paper should be carefully controlled. Although tests have not been made on other strength properties as compression and shear or on any of the electrical properties, in view of the foregoing work, it is a reasonable assumption that moisture in the impregnated sheet will also affect these properties and should be investigated.

Protein-Formaldehyde Reaction

The protein-formaldehyde reaction. I. Collagen. Edwin R. Theis. *J. Biol. Chem.* **154**, 87–97 (June, 1944).

The collagen-formaldehyde reaction is discussed in detail. It is shown that the fixation of formaldehyde with collagen in no way affects the acid-binding capacity of collagen, but does affect the base-binding capacity. No shift in the isoionic point could be demonstrated as due to formaldehyde fixation. Correlation between data for temperature and formaldehyde fixation is shown. Correlation is shown between data for shrinkage temperature and formaldehyde fixation. 26 references.

The protein-formaldehyde reaction. II. Wool. Edwin R. Theis. *J. Biol. Chem.* **154**, 99–103 (June, 1944).

The acid- and base-binding capacity of purified wool keratin has been studied by an entirely different method from that generally used in such an investigation. The nature of the curve is similar to the titration curves obtained by other investigators. The acid- and base-binding capacity of formaldehyde-treated wool keratin has been investigated and shows no change in the acid zone or at the zero combination point. The formaldehyde fixation by wool keratin is given and is somewhat similar to that obtained for collagen. An interpretation of the data is given.

Wool

The testing of the resistance of wool to bacteria. I. B. Schulze and H. Sommer. *Melliand Textilber.* **24**, 105–8 (Mar. 1943). (In German) (through *Bull. Inst. Paper Chem.* **14**, 341, June, 1944).

Wool is readily attacked by bacteria under favorable conditions of moisture, temperature, and chemical (i. e., alkaline) medium. Fibers with non-damaged scales are hardly ever attacked; the greatest bacterial damage to felts in the paper industry occurs on wool which has been degraded by alkaline pretreatment. An inhibiting effect of bacterial activity can be obtained by treatment with copper salts, certain grades of Eulan, decreasing the swelling of the wool

fiber by chromation or tanning agents, etc. The purpose of the present investigation was to compare the existing method of bacterial destruction with the chemical procedure by Burgess employing a buffered solution of trypsin (cf. *J. Textile Inst.* **25**: T289–94 1934) in order to decide on the most suitable procedure for evaluating the resistance of wool to bacterial disintegration. Seventeen differently pretreated wool samples were subjected to the reaction of bacteria and a 0.25% trypsin solution according to Burgess. The wool damage was evaluated titrimetrically and microscopically, the latter method giving the more accurate results. Burgess recommends a maximum reaction period of 7 hours, which the authors extended to 96 hours for a very far-reaching differentiation. The attack by bacteria, as stated by Burgess, is much slower than that of trypsin solution; no differences were found when *Bacillus subtitis* was used alone or with a mixture of other bacteria. However, apart from the difference in the rate of reaction, other fundamental differences exist between the two methods, so that they cannot always be used interchangeably. Samples pretreated with Eulan N or potassium dichromate were found to be more or less bacteria resistant; however, most of them were still disintegrated by the trypsin solution. The results of the experiments are summarized in two tables.

Wool Shrinkage

Reducing wool shrinkage and felting with melamine resins. E. P. Johnstone. *Am. Dyestuff Reptr.* **33**, 301–3 (July 3, 1944).

Treatment with halogens or halogen derivatives, enzymes, caustic alkalies, organic and inorganic reducing agents, and sulfides and hydrosulfides, has been found to reduce shrinkage of the wool fiber. In general these chemical treatments require careful control to prevent excess fiber damage and are otherwise not ideally suited to application in the textile plant. Recent investigations have endeavored to reduce shrinkage by application of additive agents which do not chemically attack the fiber; these have included ethyl cellulose, cellulose acetate, polymerized urea-formaldehyde and polymerized formaldehyde. Methylated methylol melamines are water soluble, and applied to wool and polymerized by heat treatment in the presence of a catalyst have been found to reduce the shrinkage of wool with a greater degree of permanence than obtained with urea-formaldehyde resin. For example, after ten launderings the former treatment showed a shrinkage of about 3 per cent whereas the latter type showed 35 per cent or more. Microscopical investigation showed the melamine resin to be uniformly distributed, probably between if not within the cortex cells of the wool fiber rather than merely a modification of the epithelial scale surface.

Wool—Action of Halogens

The action of halogens on wool. Part I. Factors influencing the amount of halogen adsorbed from solutions in carbon tetrachloride. C. S., and Selim A. Whewell. *J. Soc. Chem. Ind.* **63**, 121–3 (Apr. 1944).

The adsorption of chlorine by wool from solutions of the gas in dry carbon tetrachloride is affected by time of adsorption, concentration, bulk ratio, temperature, and the regain of the wool. The amount of chlorine adsorbed depends on the type of wool and on any chemical treatment to which it may have been subjected, reagents causing deamination having much greater effect than those which attack the disulfide linkings.

DYEING: BLEACHING: FINISHING

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Effect of pH on Light Fastness

Effect of fiber pH on light fastness of dyed cotton. C. A. Siebert and C. A. Sylvester. *Am. Dyestuff Reptr.* **33**, 311–12 (July 17, 1944).

Khaki and olive drab uniform and herringbone twill cottons processed in different plants with dyes considered identical were found to vary widely in their fastness to weather and light. In order to investigate this variation in fastness a series of experiments have been carried out to determine if there is difference in light fastness between dyed cotton fi-

ished to retain a mild acid and to retain a mild alkali. The results show that the pH of the finished cloth does exert an important effect on the light fastness of certain dyes. For example, (1) in the pH range between 3 and 5, the light fastness of the cotton dyed with many direct, developed and sulfur dyes is inferior to when the pH approximates 7, (2) azoic and vat dyes show only minor differences under the above conditions, (3) the fastness of sulfur blacks is consistently superior at the higher pH values, (4) at higher pH values, e.g. up to 9.5, vat dyes are outstandingly inferior in light fastness to the same vat dyes left neutral or mildly acid. Soap left in vat dyed goods may thus cause considerable loss in light fastness. Complete rinsing out of the soap is probably impracticable; possibility of buffering such soap finishing treatments has not yet been determined. The alkali left in the cloth apparently has not combined chemically with the dye or cloth since even after storage complete rinsing restores both pH and original light fastness. Some of the best vat dyes are found to be noticeably different in shade when the pH of the cotton is 7 and when it is above 9. The vat, developed and direct dyes which were tested and found inferior when the finished dyed cotton had a high pH value are listed.

Leather Dyeing

Leather and how it is colored. B. Firth. *Textile Colorist* **66**, 78–82 (Feb. 1944); 195–7, 200 (May 1944).

The five principal methods of tanning leather (vegetable, chrome, alum, oil and formaldehyde) and the properties characteristic of each process are briefly described. The selection of dyes for leather is determined by (a) the type of tannage, (b) the degree of penetration required and (d) the use to which the dyed article will be put. The dyestuff groups commonly used on leather are: acid, direct (called Chrome Leather Colors in the trade), basic, Neolan, Eriochrome, and to a lesser extent sulfur colors; the fastness properties of each on leather is generally comparable to its fastness on textile material. Skins are prepared for dyeing by a thorough wetting out. Since temperatures over 120 F injure vegetable tanned leather cool dyeing dyes must be chosen for goods so tanned. Basic colors have good affinity for vegetable tanned leather forming a color lake with the tannin and yield bright shades but of poor fastness to light and crocking. Acid and Neolan (a type of acid dyeing dyestuff) colors are used to obtain uniform and well penetrated results. Basic dyes have no affinity for chrome tanned leather and here acid and direct dyes are successfully used, principally browns and blacks since footwear is the major outlet for chrome hides and calfs. Oil tannage, usually associated with chamois leather, permits the use of acid, chrome, direct, Neolan, Eriochrome and sulfur dyes, but as a high degree of fastness is usually desired the last three named dyes are most often used. Glace (alum dressed) leather must be desized with malt diastase before dyeing; it has little affinity for synthetics, so natural dyes are employed, though in the production of washable glove leather where it is necessary that the leather tolerate water a retanning with chrome salt is carried out and Neolan dyes may then be used with good results. Owing to its white color formaldehyde leather can be dyed in the most delicate shades; dyeing procedure is the same as for chamois leather. The final process before drying is known as "fat-liquoring" and consists of introducing oils or fats into the leather to give necessary softness and strength; water emulsions of such oils as cod, castor or neatsfoot are often used. Leather is also colored on the surface (either for the purpose of producing an attractive lustrous finish or to hide defects in the skins) by application of a solution of a binding medium in which colored pigments are dispersed.

Rayon Dyeing

A nomogram to help in the dyeing of fine and coarse filament rayons and spun rayons to the same shade. F. Fothergill. *J. Soc. Dyers and Colourists* **60**, 93–5 (Apr. 1944).

Fine filament rayon yarn requires more dye than coarse filament yarn to appear the same depth of shade because the light rays which enter the latter and are reflected to

the eye follow on the average a longer course and undergo more absorption. In order to make the two appear the same shade, the amount of dye in the finer filaments must be as many times greater than the amount in the coarser ones as the average light path in the coarser filaments is longer than the average light path in the finer ones. If the cross sections of the coarse and fine filaments are similar in shape, the length of the average light path in each is proportional to the square root of the denier of the single filament. Based upon this relationship, a nomogram is presented which enables the dyer to determine quickly how much dye to use to match on a yarn of one filament denier the depth of shade obtained on a yarn of a different filament denier. If degrees of exhaustion on the two denier types are not the same, allowance must be made. The nomogram has been found to give values which are easily within 3% of the correct value, a difference which is not detectable visually.

Phtalocyanine Pigments

The phthalocyanine pigments. S. A. Scully. *Interchem. Rev.* 3 (Summer, 1944).

The phthalocyanines, an important and comparatively new group of pigments are described, and some methods of preparation are given. Copper phthalocyanine is the most widely used. The group of phthalocyanine colors has helped fill the requirements of the trade for green and blue pigments and has found application in all types of decorative finishes. 24 references.

Alumina in Sizing

The role of alumina in the mechanism of rosin sizing. John C. Redd. *Paper Trade J.* 119, 42–7 (Aug. 17, 1944).

An investigation of the variables affecting the precipitation of alumina has been carried out with reference to the adsorptive power of the alumina for arsenious oxide. The results of this study were correlated with the ability of precipitated alumina to form colloidal solutions and with the ability of the precipitate to develop sizing in a pulp-size system. The results of the investigation on precipitated alumina were extended to the development of a method for the formation of colloidal alumina solutions, whose activity was studied by their ability to precipitate a colloidal system of oppositely charged particles—namely, Pro- size. The effect of alum, precipitated alumina, and coloidal alumina solutions was studied in sizing systems. The use of colloidal alumina solutions has presented a method of studying alumina as an independent variable in the sizing reaction. The results obtained have further clarified several of the problems of the rosin sizing action, and have revealed hitherto unknown factors in the mechanism of rosing sizing.

Surface-Active Agents

Surface-active agents are chemical achievements. Hugh H. Mosher. *Textile World* 94, 109–13 (Aug. 1944).

The diverse wetting, penetrating, emulsifying, and dispersing agents, commonly classified as surface-active agents have done much to revolutionize all wet-processing operations. The fundamental principles upon which these compounds depend for their action are clearly described. Some uses for cationic and non-ionic auxiliaries which are among the newer developments in the field of surface-activity are given.

Proofing Finishes

War lends impetus to proofing finishes. Norris Rabold. *Textile World* 94, 90- (Aug. 1944).

Advantages and drawbacks to various treatments and formulations available for flameproofing, mildewproofing and water-proofing of textiles are reviewed by the chief chemist of a large bleachery.

Water in the Textile Industry

Water in the textile industry. I—Process water. Lewis B. Miller. *Cotton* 10 85–8, 132–3 (July, 1944) **II—Textile wastes.** *Ibid.* 108, 98–101 (Aug. 1944)

These are the first articles in a series which will discuss in detail the uses of process water in the textile industry, its chemical properties,—hardness, turbidity, color- and will present tentative specifications for

water quality for use in manufacturing. Part II deals with wastes from textile plants, particularly from the standpoint of the recovery of materials which may be re-used or of valuable by-products which may be recovered; the effects of industrial wastes upon surface waters; and the treatment of those wastes in order to fit them for discharge to surface waters, where such treatment is required.

FIBERS: YARNS: FABRICS: MECHANICAL PROCESSES

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New Synthetic Fabrics

Post-war trends in new synthetic fabrics. W. E. Coughlin. *Silk J. Ray. World* **20**, 35, 37 (Feb. 1944).

Since the manufacturer can alter the properties of synthetic fibers at will, these offer varied fabric effects not possible with natural fibers. Entirely new spun rayon blends which may be used for topcoats and tailored sportswear are anticipated. Acetate-wool blends promise durable washable sweaters. High tenacity rayon, nylon and Fortisan may be used for sheer but strong lingerie and blouses. Vinyon, Saran and casein fibers will probably find their chief outlets in household goods and industrial uses rather than clothing. Resin-treated raincoats and sportswear will probably find good markets.

Vinyon Fabrics

Uses of Vinyon fabrics: wide scope in many chemical and industrial fields. Anon. *Silk and Rayon* **18**, 438 (Apr. 1944).

The low shrinkage temperature of Vinyon is the only important property that prevents it from being the universal filter fabric. It is not recommended for service at temperatures above 65° C, or 150° F. Its unique chemical inertness towards all strong acids and alkalis makes it a most satisfactory filter material in many diversified industries. Advantage is taken of its thermoplasticity in many cases, particularly in the development of a new method of molding. Fabrics woven of Vinyon are wrapped around forms, and heated until the fabric shrinks tightly about the form. Or, at higher temperatures, it fuses about the form. Many variations of this technique are possible to obtain novel effects.

Water Drops on Textiles

Water drops on textile fabrics. H. Reumuth. *Photographie u. Forsch* **3**, 304–14 (1942); *Chem. Zentr.* 1943, **I**, 2650–1 (through *Chem. Abstr.*, 1944, **38**, 4450[9]).

A discussion of water-repelling and water-absorbing textile fibers, of the swelling tendency of viscose and cuprammonium rayons and other fibers, of the improvement of water-repellance (with maintenance of air permeability) by impregnation with Ramasit K (I. G. Farbenindustrie) or with Persistolgrund B and Persistol salt conc. (I. G. Farbenindustrie), and of the decrease of the swelling properties of synthetic fibers by means of Kaurit WF 110 or KF (I. G. Farbenindustrie) or according to the wash-proofing method of Stockhausen. 17 photomicrographs.

Mechanical Handling

Mechanical handling eliminates labor. Anon. *Textile World* **94**, 119–21 (Aug. 1944).

The materials handling system installed at Union Mfg. Co., Union Point, Ga., is described. Photographs of the various carrier installations are shown.

MISCELLANEOUS

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Air Conditioning

Rayon and air conditioning. A. H. Milnes. *Silk J. Ray. World* **20**, 34, 38 (Feb. 1944).

The following temperatures and humidities are recommended: for winding, twisting, etc., 55–60 per cent R.H. and 80° F; for spun rayon, 50–60 per cent R.H. and 80° F; for weaving, 50–65 per cent R.H. for viscose and up to 75 per cent for acetate and even 80 per cent for spun rayon; for knitting, not less than 65 per cent R.H. An air conditioning plant fitted with a refrigerating unit is desirable,

although not essential, for processing rayon. The use of a refrigerating unit may be avoided by choosing as high R.H. and temperature as possible within the above-mentioned limits. Thus, on hot days the atmospheric temperature will seldom rise above room temperature and full advantage may be taken of evaporative cooling. It should be noted that this paper was published in England where lower average temperatures prevail than in the U. S.

Q.M.'s Sampling Plan

Sampling plan developed by Q.M for woolen textiles. Anon. *Textile World* **94,** 88–9 (May 1944).

The recently developed sampling plan by which statistical methods are applied to the inspection of wool textiles at the Philadelphia Quartermaster Depot is briefly described. Under this plan when first samples reveal a fraction defective which is greater than the allowable, a second sample is called for as indicated in a table which is shown. The sampling plan is designed at about a 10 percent consumer risk which means that the Depot runs the risk of one time in ten accepting a shipment which exceeds 10 percent defective (on the basis of ⅛ yard for each defect) based on the samples from individual lots. The sampling plan calls for basing acceptance or rejection of a shipment on the basis of sampling. In the past it was the practice, when a sample revealed a percent defective which exceeded the acceptable quality level, to examine that shipment 100 percent. The plan as developed accomodates various sizes of shipments. Also consideration is given to certain economic factors which influence the amount of sampling which should be done. For example, material which cost $3.00 a yard justifies more inspection than material costing 75¢ a yard.

Water Purification

Demineralization—new method of treating process water. Anon. *Silk and Rayon* **18,** 435 (Apr. 1944).

The "Permutit-Deminrolit" process has opened the possibility of producing very pure water on a large scale at low cost. The salts in crude water are removed in two steps: The water first passes through a pressure cylinder containing hydrogen ion exchange material which converts the dissolved salts to the corresponding acids. Finally this effluent passes through another pressure cylinder containing material which absorbs these acids. The resultant water generally contains a trace of sodium bicarbonate (5–10 p.p.m.) and sodium chloride (2 p.p.m.). Any dissolved silica passes through the process unchanged. The total dissolved solid in the effluent is generally of the magnitude of 20 p.p.m. Dissolved CO_2 is removed by aeration.

Polyethylene Resin

Polyethylene—a new thermoplastic. J. W. Shackleton. *Modern Plastics* **21,** 99, 178–80 (Feb. 1944).

The important physical and chemical properties and some of the uses of this interesting new resin are tabulated. This resin is made by the polymerization of ethylene, C_2H_4, and is therefore a pure aliphatic hydrocarbon with all the chemical inertness, low water absorption, and low specific gravity characteristic of these hydrocarbons. However, it is greatly superior in physical properties to such solid hydrocarbons as parrafin wax.

Chemical-Resistant Wood

Lignum-Vitae wood for processing applications. John R. Callahan, *Chem. & Met. Eng.* **51,** 129–31 (May, 1944).

True lignum-vitae heartwood has a closely interwoven grain, a density of 72–83 lbs. per cu. ft., is highly resistant to compression and ordinary wear, and will withstand working pressures up to 2000 lbs. per sq. in. It contains 30 percent by volume of a resin known as "guaiac" which is insoluble in water, weak acids and numerous other chemical solutions. It is soluble in alcohol, ether, and certain other organic solvents. This resin lends to the wood the property of being self-lubricating, thereby making it valuable for bearings on certain textile machines. In bleacheries, rolls of lignum-vitae are replacing those of stainless steel which corrode to the point of uselessness in about three weeks, whereas lignum-vitae rolls show only slight discoloration during the same period.